SCIENCE

VOL. 78 FRIDAY, AUGUST 25, 1933 No. 2017

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SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal

Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

COSMIC-RAY LIGHT ON NUCLEAR PHYSICS[1]

By Dr. ROBERT A. MILLIKAN

CALIFORNIA INSTITUTE OF TECHNOLOGY

(1) ENERGY RELATIONS COMPATIBLE WITH ASTON'S CURVE

IT was Aston's success in 1927 in measuring with his isotope method the exact masses of most of the elements and then in plotting a smooth curve connecting the mass of the hydrogen atom as it appeared in each element against the atomic weight that first gave us a quantitative, thermodynamic way of getting definite information about nuclear transformations. For if the mass-energy equation of Einstein, $E = mc^2$ (1905), was a valid generalization—and every week is now adding new proof of its validity—it and Aston's curve together told at once what kind of nuclear transformations were possible and what impossible among the 92 elements which make up the entire physical world as we now know it. Cameron and I then first tested whether this method would predict correctly the observed release of energy in known radioactive transformations, and its success in so doing[2] at once emboldened us to try to use it for the interpretation of the banded structure of the cosmic rays brought sharply to light by our 1925 and 1927 and 1928 studies of the absorptive characteristics of these rays as a function of depth beneath the surface of the atmosphere. These measurements, carried out in deep mountain lakes, extended from about 8 equivalent meters of water beneath the top of the atmosphere to 80 meters, and could only be interpreted as due to three or more cosmic-ray bands, to the absorption coefficients of which per meter of water we had given at that time the values .35, .08, .04 and .02, respectively,[3] though we pointed out with great care

[1] Address delivered at the "Century of Progress" meeting of the American Association for the Advancement of Science held in Chicago on the evening of June 21, 1933. It immediately followed Dr. F. W. Aston's address on "The Story of the Isotopes," SCIENCE, 78: 5, 1933.

[2] Millikan and Cameron, *Phys. Rev.*, 32: 537, 1928.

[3] Millikan and Cameron, *Phys. Rev.*, 31: 929, 1928, and 32: 548, 1928.

that our data only made it possible to explain the general type of solution, and that the numbers themselves must not be taken too seriously. The only thing we insisted upon was at least three bands of absorption coefficients, one in the general neighborhood of 0.35, one in something like one fourth of that or around 0.1, and still another something like a fourth of that or around 0.02. And with the theoretical formulae that we then had connecting absorption coefficients and energy we computed from Aston's data that the only way bands of such penetrating power could be formed, through the release of energy brought about by any possible atomic transformation was by the synthesis of helium out of hydrogen, for the .35 band, of oxygen out of hydrogen for the second band, and of heavier elements for the higher bands. But I felt it very necessary to find more direct ways of getting the energies of these bands, since all theoretical formulae are suspect when they have to be extended into regions so remote from those in which experimental checks have been obtained. Hence, a good deal of my own time and that of my associates has been directed since 1929 to more direct and dependable measurements of these energies. It is the main results thus far obtained of these direct energy measurements that I wish to present herewith.

But first as to what can be predicted from Aston's curve. The idea of using atomic synthesis to produce energy which manifests itself in electro-magnetic radiation is no new idea. Harkins and a great many others used it as early as 1915 or 1916 to explain the enormous radiation from the stars. But to apply it to the explanation of the banded structure of the cosmic rays and yet account for their most extraordinary property, namely, the uniformity of their distribution over the celestial dome, *i.e.*, their complete independence of the sun or the Milky Way, required a clustering of hydrogen atoms under the extremely low temperatures and pressures existing in interstellar space into cosmic dust or condensed vapor not unlike the clustering of water molecules that take place at higher temperatures in our atmosphere when clouds are formed, and then an occasional sudden formation of a helium atom, an oxygen atom, an iron atom, or, if you will, a uranium atom. According to Aston's measurements, the energy released in that synthetic process would be about 27,000,000 volt electrons for the formation of helium, 116,000,000 volt electrons for oxygen, 500,000,000 for iron, and about 1,650,000,000 (1.7×10^9) for uranium. But if this type of process actually occurs there is no reason for stopping with uranium, for even heavier elements might be formed by the same process, which would, however, be unstable and begin to slide down the Aston curve, just as uranium is doing, until they thus become transformed into the more stable atoms. In other words, they might reach this end result by two routes: (1) direct formation out of hydrogen atoms or ions; and (2) direct formation of heavier elements and the subsequent slipping of those elements by the throwing off of alpha particles down to the end nuclear results. This hypothesis would make it possible for energies to appear considerably above the 2×10^9 volt value.

(2) A Free Positive and Negative Electron-Pair often Result from the Collision of a Sufficiently Energetic Photon with an Atomic Nucleus

Now, the first new result I wish to show to-night has to do with the degree of success which such a synthesis hypothesis has had to date in fitting the observed *directly measured* energies of the cosmic rays.

On the road to it, however, I must point out that everybody now knows that these energy measurements have resulted, as reported by Dr. Anderson in September, 1932,[4] in the discovery, first, that the cosmic rays, in being absorbed by the nucleus of the atom, yield free positive as well as free negative electrons. I had the pleasure of showing Dr. Aston one of the positrons, as we now call them, when he came as a visitor from the Cavendish Laboratory at Cambridge to the Norman Bridge Laboratory at Pasadena early in September, 1932. I told him we should not publish the discovery until we had several more, but we got them within a few weeks, and released the preliminary publication,[5] and within the next few months had made the evidence quite as convincing as that I am showing you to-night. In February or early March Dr. Anderson was delighted to hear, through the daily press, that the Cavendish Laboratory group had repeated and confirmed his findings on their own account. The most surprising aspect of this discovery is that these positrons are obtained not alone from cosmic-ray nuclear encounters, but just as well, as Dr. Anderson announced in April,[6] and as I shall show you in detail to-night, when gamma rays from thorium C″ collide with a nucleus of the atom. Indeed, the photographs I am showing you to-night indicate that ***both in the case of thorium C″ rays and in that of cosmic rays a common procedure when a photon is absorbed by the nucleus of an atom is for a positive and negative pair to appear together,*** both generally having the same mass, namely, the mass conventionally associated with the free negative electron. Indeed, the pictures I am this evening presenting show the first quantitative measurements of the

[4] Carl D. Anderson, SCIENCE, 76: 238, 1932; see also *Phys. Rev.*, 43: 491, 1933.
[5] Millikan and Cameron, *Phys. Rev.*, 32: 537, 1928.
[6] Carl D. Anderson, SCIENCE, 77: 432, 1933.

mass of the positron. Dr. Anderson's former results fix that mass as not different from the mass of the electron by more than a factor of 20, but these results herewith shown actually *measure* the mass of the positron and reveal it the same as the mass of the free negative electron, with an error of not more than 30 per cent.

(3) The Distribution of Energies among Cosmic-Ray Particles at Sea-Level

But now as to our findings at the Norman Bridge Laboratory from the measurement of the energies of the cosmic rays. The most striking result of Anderson and Neddermeyer's energy determinations is that in the group of measurements on particles of energies between 60,000,000 and 3,000,000,000 volt electrons, *the positive and negative energies are alike both as to their numbers and the distribution of their values.* It is true that when the energy measurements are confined to values below 60,000,000 volts and when, further, associated tracks alone are considered, the negatives are 5 or 10 times more numerous than the positives. This last result is presumably due to the fact that close collisions of either positives or negatives with the *extranuclear* negatives of course produce in general only *low energy* negatives, so that this particular source of negatives quite naturally vanishes for energy ranges of the order of 60 million volts or more. The first result, however, namely, that the positives and negatives show an approximate equality both in number and in energy distribution in these high energy ranges, is a very important and at first sight a very surprising one, since the positives can only come from nuclear encounters, while Compton encounters of photons with extranuclear electrons would be expected to make the yield of negatives much greater than of positives. To understand why this is not so one must consider the results of Anderson and Neddermeyer's recent measurements[7] of the energies of the pairs produced by the absorption within their cloud chamber of the gamma rays of ThC″. The sum of the measured energies of such a pair, not at all, however, equally divided between two, comes out in practically all the cases tested within about a million volts of the total incident energy, which is in this case 26 million volts, and since, according to the Dirac theory, it requires an energy of $2mc^2$, which for the electronic mass is equivalent to a million volts, to produce a pair, the foregoing figures mean that in this case, from the point of view of this theory, *the absorption of the photon by the nucleus has been of the photoelectric sort, the total energy of the incident photon appearing in the ejected pair of electrons.* The general validity of this conclusion, however, does not depend upon the correctness of the Dirac theory, for it follows approximately, at least, from the energy measurement alone in the case of ThC″. That it holds also in the cosmic-ray field is suggested by the fact that here, too, the typical result of a nuclear collision is the appearance of a positive and negative electron pair, the positive seeming generally to have the greater energy. In our very first paper on the direct measurement of cosmic-ray energies,[8] Dr. Anderson and I, though not guided particularly by the Dirac theory, drew the conclusions, from our observed fact of the large percentage of *associated* tracks in which positives and negatives appeared together, that "the incident cosmic rays are absorbed *primarily* by the nucleus, rather than by extranuclear electrons as heretofore generally assumed," and that "practically the whole of the energy of the incident photon, or any fraction thereof, should be able to appear in a single ejected proton or electron, or in a number of such." These conclusions are strongly supported by Dr. Anderson's new measurements, for these show that, though the negatives appear in notably greater number than do the positives when the incident rays are the gamma rays from ThC″ (for here Compton encounters with extranuclear electrons add single negatives to the positive and negative pairs coming from nuclear encounters), yet when the energies rise to values of the order of 100 million volts or more the Compton encounters with extranuclear electrons have become negligibly small in comparison with the nuclear encounters so that practically the whole absorption is nuclear. Whether the whole energy of the incident primary goes into the electron pair, as Dirac's theory requires, or whether more general conditions of nuclear collision will need to be set up, it is too early to say with certainty, though for reasons stated below the Dirac theory should be treated with great caution. Oppenheimer and Plesset, of this laboratory, have just published a paper[9] dealing in detail with the application of that theory to Dr. Anderson's results. The theory thus far (1) fails to account for "showers," (2) it seems to require an absorption proportional to Z^2 (Z = atomic number) which cosmic-ray experiments definitely do not confirm at all (see below), and (3) one of Dr. Anderson's photographs gives the sum of the energies of the particles coming from one nuclear encounter somewhat over 2,000,000 volts instead of a million volts less than the incident energy of 26 million. But in any case, whether this Dirac theory fails or not, the experimental evidence so far obtained at least favors the view that very frequently (1) the positives and negatives appear in pairs, and (2) the whole energy of the

[7] Anderson and Neddermeyer, *Phys. Rev.*, 43: 1034, 1933.

[8] Robert A. Millikan and Carl D. Anderson, *Phys. Rev.*, 40: 325, 1932.

[9] Oppenheimer and Plesset, *Phys. Rev.*, 44: 53, 1933.

incident primary ray appears in the group of charged particles (two or more) which result from a nuclear encounter.

This in itself, if correct, is of great significance for the interpretation of cosmic-ray ionization, for it means that *the observed energy distribution of the cosmic-ray particles is not far from the energy distribution of the primary rays producing these secondary ionizing particles.*[10] This lends new interest to Dr. Anderson's new and very careful measurements on this distribution, the results of which may be roughly stated thus. One third of a group of seventy carefully selected and measured tracks, obtained in our apparatus here at sea-level, all of which actually fall within the energy range 60 million volts to 3,000 million volts, have an energy under 350 million volts. One half have an energy under 550 million volts, 75 per cent. have an energy under 1,000 million volts. The ten highest energy tracks all lie between 2×10^9 and 3×10^9 volts. This distribution, in substantial agreement with that obtained by Kunze,[11] whose figures, however, require some correction in view of the fact that the positives are positrons, seems to settle the fact that *the large number of coincidences observed by Rossi*[12] *with counters separated by a meter of lead can not possibly be due to the passage of one and the same charged particle through both counters for* (see below) *it requires a three billion volt* (3×10^9) *particle to traverse a meter of lead and there is actually a negligible number of such particles.*

The foregoing observed distribution of energies also means that if in the equatorial belt at sea-level there are asymmetries in particle-directions due to the earth's magnetic field, as seems to be indicated by reports from Johnson's counter experiments at Panama,[13] these asymmetries must find their explanation in the effect of the earth's field *upon the secondary charged particles released within the atmosphere* by the absorption therein of the magnetically undeviated primary cosmic rays, since no appreciable number of particle rays of the energies actually observed by Anderson and Kunze could have come through the earth's magnetic field into the equatorial belt anyway. According to our latest observations the retardation of the earth's atmosphere can scarcely be more than 3,500,000,000 volts, while to get to the earth at the equator through the earth's magnetic field requires, according to Epstein and LeMaitre and Vallerta's computations, at least 7,000,000,000 volts. If incoming rays of that or of higher energies were responsible for an appreciable part of the equatorial ionization at sea-level they would of course appear prominently in Anderson's measurements, as they do not. There can be no question that these same *low energy* rays observed by Anderson, all of which at the magnetic equator and more than nine tenths of which in temperate latitudes are secondaries, are the very rays which produce the great bulk of Johnson's counter responses. If there are more of these that correspond to positives than to negatives in the equatorial belt it may be because, though the same number of positives and negatives are formed within the atmosphere, the negatives disappear by atomic captures, while the positives do not, or, on the other hand, because more positives are produced by photon collision with the nucleus, but outside the equatorial belt this excess is balanced by the entrance of some excess of negatives entering with the photons in sufficient numbers to account for Anderson's observed equality of positives and negatives at Pasadena. Some nigh energy negatives due to Compton encounters with extranuclear electrons contributed to bring about this equality. The evidence here reported for this equality is of course statistical and might therefore conceivably involve an error of as much as 10 per cent. Indeed, Anderson and I[14] have heretofore published the estimate, based upon less careful counts, that the positives are somewhat in excess and Kunze[15] agrees with this conclusion. If this former estimate of ours should turn out to be correct this situation would constitute a fourth and probably fatal blow for the Dirac theory, but would support our own earlier view[16] that these positrons are in some way definite elements of nuclear structure. It is a very significant fact that we have never found a pair the sum of whose energies was as high as the highest energies exhibited by single tracks of both positive and negative sign, thus suggesting the possibility of nuclear photo-electric absorption of the non-paired type.

The fact that for cosmic rays practically the whole absorption is nuclear of course means that *all the computations made thus far, both by myself and by others, in the endeavor to obtain cosmic-ray energies from absorption coefficients through the aid of the Klein-Nishina formula are now invalid.* How this nuclear absorption actually varies (1) with the atomic number of the absorber, and (2) with the incident energy, we have already some indications which we hope will soon lead to a quantitative law, but for the present we can present only the following statements.

[10] This will be particularly true with an arrangement like Anderson's, in which most of the observed secondary particle rays are near the beginning of their ranges when they enter the observing chamber, since most of them originate in the iron and other dense materials of roughly estimated thickness of say 12 cm immediately around that chamber.

[11] Paul Kunze, *Zeit. für Physik*, 80: 559, 1933.

[12] Bruno Rossi, *Zeit. für Physik*, 82: 151, 1933.

[13] See also Johnson and Alvarez's reported observations in *Phys. Rev.*, 43: 834–35, 1933.

[14] *Op. cit.*

[15] *Op. cit.*

[16] Millikan and Anderson, *op. cit.*

Both according to Schindler's[17] indications and our own, this nuclear absorption seems to increase very slowly with the atomic number of the nucleus—apparently somewhat less rapidly than with the first power of Z. As to its variation with incident energy, we have the following definite facts. The absorption coefficient of the hard monochromatic component of ThC″ of energy 2.6 million volts is but some seven times that of the softest component of the cosmic radiation. For Neher and I have recently measured very accurately this softest component up to an altitude of 8.9 km. (29,200 ft.) in lat. 34 N. and up to 6.7 km. in the equatorial belt, and in the latter region, where the earth's magnetic field has removed all incoming charged particles, we find the absorption coefficient of this quite homogeneous band to be 0.55 per meter of water, and this checks nicely with Kölhorster's original measurements at this 9 km. height. This is from 4 to 5 times our measured value of the absorption coefficient of the rays existing at sea-level, where Anderson's direct measurements place the energy of the average cosmic-ray particle at about 500 million volts. Since, further, Anderson finds the absorption even at 2.6 million volts to be at least 30 per cent. nuclear, it becomes possible to make some sort of a reasonable interpolation between 2.6 million volts and 500 million volts, and thus arrive without the aid of any theory at limits for the mean energy of this least penetrating cosmic-ray band. We shall soon be able to narrow the spread between these estimated limits, but for the present in order to be very conservative I will merely say that this mean energy of the softest cosmic-ray band—which actually carries 90 per cent. of the energy arriving at the earth in the form of cosmic rays, must from this mode of approach lie somewhere between 25 million and 250 million volts.

But there is a second way in which we are able to gain some definite knowledge as to the energies of the cosmic-ray particles. Dr. Anderson has measured directly by means of the changes in curvature, in a 17,000 Gauss magnetic field, the loss in energy of electrons in going through thick lead bars inserted within the cloud chamber, and has found that 300 million volt electrons lose on an average about 35 million volts of energy per cm. of lead traversed, and this checks reasonably well with Heisenberg's theoretical calculations. But I find the number of cosmic-ray ions produced in my unshielded electroscope at Pasadena to be 36.2, while inside of a lead shield 10 cm. thick it is but 25.3, which means that at least 30 per cent. of the cosmic-ray particles existing in this locality have insufficient energy to pass through 10 cm. of lead, that is, have energies below 350 million volts. This 30 per cent. is of course a lower limit, since in this reasoning I am neglecting the new particles produced within the lead by the absorption of the primary cosmic rays. But I may be altogether certain in this way that *at least* 30 per cent. of the rays at sea-level have energies under 350 million volts, and this conclusion is in entire agreement with Dr. Anderson's direct measurement of 33 per cent., as given above. As a further check on this method I made precisely similar measurements at Pasadena with and without lead screens 7.4 cm. thick, and found thus that the cosmic-ray ionization inside the lead was 76 per cent. of the cosmic-ray ionization obtained without the lead shield, which means that at least 24 per cent. of the particle rays at sea-level have energies under $(7.4 \times 35 \times 10^6) = 260$ million volts. This also checks well with Dr. Anderson's measured tracks, for he finds that 17 out of 70, or 24 per cent. of these, have energies under 260 million volts. It is of course to be strongly emphasized that this method gives only *a minimum value* for the number of particles having energies under the computed voltage, since it ignores all the new secondary particle rays which are created within the lead and find their way into the ionization chamber. The error thus introduced becomes larger as the thickness of the lead is decreased until when this thickness reaches, for example, 15 mm., the ionization at 29,000 feet, according to our experiments, is actually a trifle larger than when the lead is removed. But the point that is important here is that the percentage of particle rays that have energies under 35 million times the thickness of the lead in centimeters is necessarily greater than that found by this method. About this there can be no question.

To obtain information, then, as to how cosmic-ray particle energies vary with altitude we took our new vibration-free Neher electroscopes to an altitude of 22,000 feet, obtained the ionization accurately as the plane flew for an hour at that altitude, then repeated precisely the same experiment when the electroscope was surrounded by the 10 cm. lead shield. We thus found that the ionization within the lead was now but 32.5 per cent. of that when the lead shield was removed. In other words, certainly more than 67.5 per cent., and I think it altogether safe to estimate that more than 75 per cent. of the particle rays existing at 22,000 feet have an energy under 350 million volts. *The rays at this altitude are, then, on the average very much less penetrating than the rays at sea-level,* where this same method gave 30 per cent. as a minimum with energies under 350 million volts. By then taking up lead screens 7.6 cm. thick we proved definitely that at 14,000 feet more than 50 per cent. of the cosmic-ray particles there found have energies under 260 million volts. And, finally, by similarly taking up to an altitude of 29,000 feet these vibration-free

[17] Heinz Schindler, *Zeit. für Physik,* 72: 650, 1931.

electroscopes, first without lead shields and then with lead shields 3.1 cm. thick, we have been able to show that certainly 20 per cent. of the cosmic-ray particles existing at 22,000 feet have energies under 115 million volts, as heretofore shown, and since the rays found at that altitude are quite homogeneous a very large percentage is presumably under that energy.

All these new but very direct approaches to the energy problem seem, then, to leave no escape from the conclusion that though the mode of approach to energy through absorption coefficients can no longer be relied upon, yet *the major part of the ionization of the atmosphere by cosmic rays is due to incoming rays of an energy corresponding in order of magnitude to the synthesis of one of the lighter elements out of hydrogen.* Whether this chief band corresponds better to the energy of formation of helium out of hydrogen or of oxygen out of hydrogen these direct methods are not yet sufficiently precise to determine, though it is hoped that they may soon be made so.

It seems to be becoming popular now for the astronomers to use this synthesis-hypothesis instead of the annihilation hypothesis to explain the evolution of the heat energy by the stars. Indeed, the annihilation hypothesis seems at present to be in a state of eclipse, and the question may then be raised whether synthesis can explain both the cosmic-ray and stellar energy. There is no reason why it may not be called upon for both purposes, but with a different mechanism. The most essential element in the foregoing hypothesis as applied to the cosmic rays is the formation of clusters of hydrogen atoms which I have called hydrogen dust, and of course such clusters could not possibly either be formed or hold together save at exceedingly low temperatures, where there are very few impacts to destroy them. This kind of atomic synthesis would then be one in which a heavy nucleus might be formed out of hydrogen by one single clamping act. If this kind of an act were possible in the atmospheres of the stars we should of course obtain cosmic rays from stellar sources, which we do not do. In Professor Lawrence's experiments, however, we find synthesis taking place when hydrogen atoms are thrown with enormous energy into the nuclei of other atoms, and of course this kind of process may take place inside the stars because of the enormous temperatures existing there, so that it is at least conceivable that within the stars atomic synthesis results in this step by step atom building while out in interstellar space the other catastrophic type of atom building occurs.

There is one final result of all our recent measurements, both with airplanes and with balloons ascending close to the top of the atmosphere, with which I might conclude. It is that according to our estimates the total cosmic-ray energies falling into the earth is approximately one half of the total energy coming in from the stars, while, inasmuch as the stellar energy is much more intense in our galactic system than in intergalactic space, the cosmic energy out there is very much more intense. From the astronomical estimates of the distribution of the nebulae we conclude that the total radiant energy in the universe existing in the form of cosmic rays is from 30 to 300 times greater than that existing in all other forms of radiant energy combined.

A HISTORY OF THE NATIONAL RESEARCH COUNCIL 1919--1933

VIII. DIVISION OF ANTHROPOLOGY AND PSYCHOLOGY[1]

By Professor A. T. POFFENBERGER
CHAIRMAN

THE Division of Anthropology and Psychology is an offspring of two committees of the Division of Medical Sciences of the National Research Council, namely, the Committee on Anthropology and the Committee on Psychology. In the course of a reorganization of the Council following the Armistice, these two committees were invited to consider plans for the formation of "sections" of the Council. A happy decision of the far-sighted representatives of these two fields, at a meeting on October 20, 1919, consolidated anthropology and psychology into the single division as it now exists.

This newly constituted division, at the first meeting after its authorization, adopted the following objectives: (1) To coordinate research activities now in progress or in prospect; (2) to encourage the development of research personnel, by a systematic search for promising material, by furnishing to possible research students information about facilities and opportunities, and by fostering the establishment of fellowships and facilities for training; (3) to foster a small number of selected research projects; and (4) to act *in an advisory capacity* on research projects

[1] This is the eighth of a series of ten articles prepared to describe briefly the nature of the activities with which the National Research Council has been engaged during the past fourteen years.

within our field, when such counsel is requested by *duly constituted agencies.*

These objectives have formed the guiding principles of the division during the thirteen years of its existence, and have unified the varied activities of its frequently changing personnel. Particularly important was the clear intention to act as adviser only when such counsel is requested, rather than to attempt to dictate policies to the research workers of the country.

The early activities of the new division were largely influenced by interests aroused through the exigencies of war. With the restoration of normal conditions, however, theoretical problems, whose importance some members had stressed from the beginning, and practical studies less intimately linked with Government agencies, came to play a larger and larger part. However, a Committee on Military Psychology, to which problems could be referred, persisted in a dormant condition until 1930.

The interest naturally aroused by the war in the diverse constituents of our population led to the study of racial groups in the United States. Several committees were organized to attack relevant problems, notably those on "An Anthropological and Psychological Study of the People of the United States," and on "Analysis of Army Data," and especially that on "Scientific Problems of Human Migration." This last committee, formed in 1922, numbered in its membership representatives of biology, sociology, anthropology and psychology. In psychology many projects were organized, notably those on the construction of an international mental test, on the measurement of primitive forms of human response, and on the measurement of mechanical abilities. Immediate results could not be expected in projects of such magnitude. However, "there have been added in the way of research experience and equipment, a series of tests to minimize language handicaps in mental measurement; a special group of tests for rating and analyzing mechanical aptitude; some fundamental pioneering in the analysis of personality; . . . an attempt to reach the fundamental psycho-neural responses upon the basis of which to project tests of social effectiveness; an effort to develop an approach to organic differences in peoples through pathological data; and an attempt to test out qualitative anthropometric characters as a method in the analysis of races."

Allied in technique to racial testing, but with distinct objectives, the work on the National Intelligence Tests represents another major activity of the division. As early as 1919 a committee was invited to capitalize the research on tests carried on during the war by developing and standardizing an intelligence scale for the group examination of school children. A set of such tests was prepared by experts selected by the division, and published by the World Book Company of Yonkers, New York, under contract with the National Research Council. Through the distribution of approximately seven million copies of the various scales and forms of this test, a needed impetus was given to the movement for the examination and mental classification of school children.

Among the earliest and most successful activities of the division are those of the Committee on State Archeological Surveys. Originally limited in scope to the problems of four Midwestern states, it has gradually extended its operations until to-day it is one of the recognized scientific agencies of the country. It coordinates the work of institutions employing trained specialists, educates amateurs in matters of scientific technique and strives to prevent the spoliation of sites and the destruction of evidence through uninformed vandalism. It has created a Ceramic Repository at Ann Arbor, Michigan, title to which is vested in the National Research Council. It publishes an annual report in the *American Anthropologist* of all "archeological field investigations in the United States and Canada," and maintains a directory of individuals and organizations in North America interested in anthropology. The publication of the "Guide Leaflet for Amateur Archeologists" and of another by a related committee, "In Quest of Glacial Man" (the latter intended for the guidance of contractors and engineers in the course of deep excavations), has done much to arouse an interest in the preservation of valuable archeological materials.

A Committee on Child Development was created in 1924 as a successor to a committee on child welfare which had cooperated in an advisory capacity with the office of the Surgeon General of the Public Health Service before the establishment of the Division of Anthropology and Psychology. It was felt that a more active committee representing "the institutes and other research workers in the field of child welfare could play a useful part in bringing the workers together, assisting them to think out their problems, establish their standards and coordinate their work." This committee, comprising representatives from psychology, anthropology, genetics, pediatrics, nutrition and medicine, has periodically circulated a digest of the pertinent literature on child welfare to those engaged in research, has awarded a series of 116 scholarships and 14 fellowships for the training of experts in the field of child development where personnel was lacking, and has performed a coordinating function among the various institutes for child welfare and the isolated workers through conferences and the visits of an executive secretary.

An interest in the human factors in highway regulation and safety, which developed within the division in 1922, crystallized in 1924 into a Committee on the Psychology of the Highway. Many specific problems have been attacked and substantial results achieved. The report of a part of this work appeared under the title "Psychological Principles in Automotive Driving" (1931). The studies coming within the range of this committee have involved the active collaboration of psychologists with physicists, optometrists, engineers, commercial organizations and officials connected with the regulation of traffic. This project furnishes an excellent illustration of how a small initial expenditure by the Council may stimulate far greater contributions from other sources and result in achievements of a recognized importance.

Experiences with rotation tests for aviators during the war led to a conference on the subject in 1920, followed by the organization of a committee on Nystagmus, later known as the Committee on Vestibular Research. Membership on this committee was extended to the Divisions of Biology and Agriculture and of the Medical Sciences, and a series of research projects of both theoretical and practical importance was outlined. Among these were researches on the mechanisms of nystagmus within the ear and within the brain stem and cerebellum, and the influence of habituation and of retinal and other forms of sensory stimulation upon reaction to vestibular stimulation.

A conference called in 1928 to prepare an adequate formulation of the problems relating to the deaf and hard of hearing resulted in the appointment of a Committee on Research for the Deaf and Hard of Hearing, comprising representatives from the fields of psychology, physics, otology and from institutions for the training of the deaf. This committee enlisted the services of some fifty specialists to deal with such problems as the measurement of capacity and achievement in the deaf, their emotional and social adjustments, methods of instructing the deaf, and special aids to hearing. A consolidated report of the activities of these subcommittees was presented to a second conference held in 1929, to which sixty-seven specialists from various fields were invited. Although financial support for a program of research in its entirety has been lacking thus far, interest has been maintained and activity continued to the present by way of a Committee on Auditory Deficiency, whose membership coordinates all the interests concerned in the problems of the deaf and hard of hearing. Aid has been secured for several specific pieces of research suggested in the composite plan adopted by the second conference, and it is known that others have been begun independently.

The youngest committee of the division, appointed in 1931, is that on psychiatric investigations, which has for its object a preliminary survey of the present state of psychiatry, its scientific foundations and therapeutic technique. The program comprises the enlistment of representatives of six aspects of psychiatric work, each of whom has presented his case in writing. These written reports are to be discussed and revised and offered to a wider circle of critics for constructive discussion. It is too early to predict the outcome of this committee's work, but it has immeasurable theoretical and practical potentialities for clarifying and systematizing this difficult field.

It is impossible, within the space available, to review the work of the many other committees of the division, dealing with vital psychological and anthropological problems. Among these are: the committee on the gifted student problem (1920–25), growing out of an earlier committee on research talent, which is responsible in large measure for the present interest in the gifted college and university student; and the committee on the experimental study of human emotions (1926–28) which held conferences and prepared a systematic research program not actively prosecuted because of lack of financial support. Something should be said, however, of the Committee on Psychological Abstracts, which cooperated with the American Psychological Association in promoting an abstract journal of psychological literature. Beginning in 1919, plans were formulated and financial aid sought, with the result that early in 1927 the first number of *Psychological Abstracts* came from the press. It was at once accepted as the indispensable tool of every active psychologist. Similarly, the publication of an index to the first forty volumes of the *American Anthropologist* has been appreciated in that field.

There have been numerous conferences, which have rendered valuable service in specific fields. For instance: there was a conference on experimental psychology (1928) to consider the needs of laboratory psychology and to seek means of encouraging its growth. Among its recommendations was the establishment of a National Institute of Psychology, which has since been independently incorporated; a conference on State Archeological Surveys in 1929, which greatly augmented interest in the preservation of valuable archeological materials throughout the Middle West; a somewhat comparable conference on Southern Prehistory to discuss similar problems in the southeastern United States, held in 1932; a joint conference (1930) with representatives of the Social Science Research Council for consideration of a specific plan for the study of racial differences in the growth period, whose results have not yet materialized; a conference of editors and business managers of anthropological and psychological periodicals which

discussed problems and united on a series of recommendations to authors and editors; a series of three conferences on the measurement of individual differences (1930–31), reports of which were made available for distribution and have enjoyed a wide circulation.

Since the creation of the Board of National Research Fellowships in the Biological Sciences in 1923, seventy-two awards have been made in this division—58 in psychology and 14 in anthropology, being approximately one third of the applications in psychology and one half of those in anthropology. Any attempt to arrive at an objective evaluation of the effects of such fellowships is beset with peculiar difficulties. The effect should be cumulative over the years. Nevertheless, it has been shown by a statistical survey of the fellows in psychology that they stand well in the upper third of their associates in the judgment of those who know them. The less tangible results in the way of keeping alive the spark of enthusiasm for pure research in those who might otherwise fall by the wayside can never be computed.

The Division of Anthropology and Psychology initiated (1929) another program of the National Research Council in aid of scientific progress, second only to the fellowships in importance; namely, the grants-in-aid of research. Financial aid, usually in small amounts, is awarded to individuals to cover needs that can not otherwise be met, in the way of apparatus, materials, technical assistance and, in special cases, field expenses. Aid of this nature has been extended to twenty-five individuals in anthropology and to twenty in psychology in amounts which average between five and six hundred dollars. Results of this service are difficult to compute in tangible units, but the encouragement of the isolated research worker, and the stimulation of institutions to support their own research will alone justify the existence and the continuation of such awards.

The Division of Anthropology and Psychology is at the same time a unit of the National Research Council and an assembly of representatives of the sciences of anthropology and psychology in the United States. With a minimum membership of nineteen, comprising a chairman and vice-chairman, and delegates chosen by the American Psychological Association, the American Anthropological Association and the Educational Research Association, together with six delegates-at-large nominated by the membership in session, it is and should be a medium for the facilitation of expression and for coordination of research in anthropology and psychology.

The following persons have served as chairmen since the organization of the division:

1919–1920—W. V. Bingham
1920–1921—Clark Wissler
1921–1922—C. E. Seashore
1922–1923—Raymond Dodge
1923–1924—Albert E. Jenks
1924–1925—R. S. Woodworth
1925–1926—George M. Stratton
1926–1927—A. V. Kidder
1927–1929—Knight Dunlap
1929–1930—Fay-Cooper Cole
1930–1931—Madison Bentley
1931–1932—Robert H. Lowie
1932–1933—A. T. Poffenberger

SCIENTIFIC EVENTS

BEIT MEMORIAL FELLOWSHIPS

A MEETING of the trustees of the Beit Memorial Fellowships for Medical Research was held on July 11, at which the annual report was adopted.

Fellowships during the present year were held by twenty-five workers, this number including one special fellowship of £1,000 in tropical medicine.

Among the distinctions gained during last year by past Beit fellows the trustees are glad to record the election of Dr. A. S. Parkes to the fellowship of the Royal Society, he being the fifth fellow who has now received that honor. Professor D. T. Harris has been appointed to the chair of physiology at the London Hospital, and Professor I. de Burgh Daly to the chair of physiology in the University of Edinburgh. Dr. G. F. Marrian was awarded the W. J. Mickle fellowship of the University of London for 1932, in sequence to another Beit fellow, Dr. P. Eggleton, in 1931.

The deed creating the Beit Memorial Trust in 1909 gave the trustees power after the expiration of twenty years to alter in some respects the regulations for award of fellowships, and they have now resolved to exercise that power in one important direction.

The opportunities for medical research have altered greatly since the trust was established. In 1909 there were in England only a few studentships. The single gift by Sir Otto Beit, with its annual income of £11,000, straightway added thirty junior fellowships to the number. This benefaction a few years after Lord Iveagh's gift of £250,000 for the building and endowment of the Lister Institute marked the beginning of the great stream that now gives such enrichment of the opportunities for scientific medicine in England.

Government help soon followed on an even greater scale, providing through the Medical Research Committee in 1914 and through the clinical units created by the Board of Education in 1919 an annual revenue now approaching £180,000, of which a not inconsider-

able part is used for maintaining junior men in research. But results of lasting value are rarely won in the apprentice years of investigation. The long devotion of a lifetime is often needed. It is in this direction that the Beit trustees believe that they may now properly consider some change of policy in the administration of their trust. Hitherto the trustees have sought no more than to ensure that the junior fellows should be well trained and that their ambition should be centered on the advance of medicine by research.

The report points out that the average achievement has been high, and many of the past fellows, men and women, are now found to be strengthening laboratories at home or abroad in physiology, pathology, biochemistry or zoology. Out of the total number of one hundred and two men who have completed the tenure of a fellowship since the first election in 1910, twenty-two have received full professorships in various universities.

But the opportunities to continue to full fruition the work that they had chosen came through the policy deliberately adopted by the Medical Research Council that all possible assistance should be given to some senior men for the prosecution of research bearing directly on clinical problems. The council has maintained one full-time senior post for such clinical research since 1916, providing a position equivalent to that of a university professor with assistants and laboratory facilities, but also with direct control of a number of hospital beds where studies could be made of some chosen form of disease. This was the position which gave Sir Thomas Lewis his needed opportunity. Last year the Rockefeller Foundation gave permanent endowment of the post at University College Hospital, and so enabled the council to create a second post elsewhere. The Beit trustees have now resolved to add a third by creating a professorial fellowship which may be held at some medical center in Great Britain where adequate facilities for work can be provided.

This professorial fellowship will be of tenure similar to that of a university chair, and the salary will absorb those of four or even five junior fellowships. It will not be required that the holder of the post shall have previously been elected to an ordinary Beit fellowship. The present announcement of policy will not be followed immediately by an appointment to the post.

THE McDONALD OBSERVATORY

CONTRACTS for the new McDonald Observatory of the University of Texas, whose 80-inch reflecting telescope temporarily will be the second largest in the world, have been signed by President H. Y. Benedict. A telegram announcing the signing of the contracts was received by Dr. Otto Struve, director of the Yerkes Observatory of the University of Chicago, who will also be director of the McDonald Observatory under a cooperative agreement between the two universities.

The contract for the observatory was awarded to the Warner and Swasey Company, of Cleveland, which has built some of the world's largest telescopes. The mounting for the Yerkes 40-inch refractor, the largest of its type in existence, and that for the 72-inch instrument of the Victoria Government of the Dominion of Canada, were produced by the Cleveland firm.

The big mirror will be made of pyrex glass, with a low coefficient of expansion, by the Corning Glass Works, of Corning, New York, which also is making the 200-inch glass for the California Institute of Technology, an undertaking which will require several years to complete.

Mt. Locke, a peak nearly 7,000 feet high in the Davis range in southeastern Texas, has been chosen as the site of the new observatory, following extensive tests made last winter and spring by Dr. Struve and his associates.

In drawing up the plans for the new observatory, Dr. Struve had the assistance of specialists of the staff of the Yerkes Observatory, including Professors George Van Biesbroeck and Frank E. Ross, Assistant Professor Christian T. Elvey and Research Associate George W. Moffitt. Dr. Walter S. Adams, of the Mt. Wilson Observatory; Dr. Harlow Shapley, of the Harvard College Observatory; Dr. J. S. Plaskett, of the Dominion Astrophysical Observatory of Canada, and Dr. Paul Guthnick, of the Observatory at Berlin, were among those who cooperated.

The instrument that has been decided upon for the McDonald Observatory will provide for a type of research different from that for which the Yerkes refractor was designed. The new telescope will have great light-gathering power and will be highly efficient for the photography of faint stars or stellar spectra. One of the important accessories will be a constant temperature room into which the light may be concentrated for spectrum analysis.

It is expected that the telescope will be ready in two years. Some parts of the mounting, however, will be completed sooner and will be used in connection with apparatus belonging to Yerkes Observatory, so that active research probably will start on top of Mt. Locke as early as this winter.

CURTAILMENT OF THE FEDERAL SCIENTIFIC BUREAUS

As a result of the economy program of the government, forty-one chemists have to date been indefinitely furloughed, essentially dismissed, from the scientific

staff of the Bureau of Standards. Their lengths of service range from one and a half to nineteen years. In many cases their separation from the service means abandonment of the type of research they were conducting. Most of them are well known in chemical circles for their contributions to the literature. Their virtual dismissal is based on grounds of economy only and is no reflection upon their scientific ability. The men are: W. O. Gordon, E. Wolesensky, J. O. Burton, H. A. Hamm, T. R. Naffziger, C. B. Overman and E. Creitz, in studies of useful products from farm wastes; F. Schofield, W. B. Knight, J. H. Wilson, paint research; H. J. Wing, A. D. Cummings, W. E. Thibodsen and H. Matheson, rubber research; J. E. Klebodka, B. C. Schmidt, E. N. Bunting, chemistry of glass and silicates; J. C. Wangler, cement; B. H. Carroll, photographic emulsions; W. A. Gonzales, W. D. Evans, G. M. Klein, leather research; H. L. Frush, J. A. Bogan, J. A. Mathews, M. T. Kanagy, carbohydrates; W. D. Ten Eyck, furs; G. E. Renfro, chromium plating; F. W. Reynolds and G. W. Ray, chemical trade standards; H. E. Cleaves, iron; H. S. Christopher, soil corrosion; M. Frandsen, thermochemistry; S. F. Pickering, gases; H. A. Buchheit, analytical reagents; M. G. Lorentz, metallography; N. P. Robie and E. A. Brisgeman, gasoline; J. B. Wilkie, mercerization, J. L. Basil, non-tin bearing metals, and C. H. Binkley, gas cell fabrics.

Appropriations and allotments for the Bureau of Fisheries investigations during the fiscal year 1934 have been reduced in the total amount of $170,000, or 42 per cent., over funds provided for such work during the fiscal year 1933. Owing to the fact that reductions in field activities and the exercise of every possible economy had been effected through reduction of appropriations in the previous year, these further cuts necessitate the reduction of permanent personnel. From a total staff of fifty-two fishery investigators and assistants, ten positions have been dropped. Those affected by separation from the service on June 30, 1933, are: Henry M. Bearse, junior aquatic biologist; Louella E. Cable, junior aquatic biologist; Arthur A. Dallas, junior biological aid; Harvey C. McMillan, junior aquatic biologist; Virgil W. Matlack, clerk; Dr. Vera Koehring, associate aquatic biologist; Marie A. Donovan, clerk; Dr. Stillman Wright, assistant aquatic biologist; Francis L. Widerstrom, junior biological aid, and Dr. Abraham H. Wiebe, associate aquatic biologist. All these have had service with the bureau from one to nine years.

The loss of personnel and the reduction of field allotments require the abandoning of investigations of such projects as a study of the life history and migrations of the striped bass in Chesapeake Bay, a study of water conditions in the Great Lakes as affected by pollution and other influences adverse to the normal replenishment of the fish supply, and a study of conserving fish life in the Pacific Northwest by means of screens and ladders in irrigation projects and hydroelectric power developments. Other investigations will be materially slowed down, and no new projects can be undertaken. Projects which depend for their success upon a series of records and observations extending over years, however, will be continued with as little curtailment as possible.

DINNER IN HONOR OF FORTY-TWO DISTINGUISHED CHEMISTS

FORTY-TWO pioneers in American chemistry who attended the Columbian Exposition in Chicago in 1893 will be guests of honor at a dinner on September 14 of the American Chemical Society at the Century of Progress Exposition in Chicago.

The "patriarch of American chemistry," Dr. Charles Edward Munroe, of Washington, D. C., who is eighty-four years old, will be among those honored. Dr. Munroe, who is still active as chief explosives chemist of the United States Bureau of Mines, is the sole surviving charter member of the society, organized in Chicago in 1876.

Dr. Gustav Egloff, director of research of the Universal Oil Products Company, Chicago, will preside at the dinner. The complete list of guests follows:

Dr. G. E. Barton, Millville, New Jersey.
Willard Dell Bigelow, Washington, D. C.
James Boyce, Marion, Indiana.
Dr. W. Gordon Brown, New Haven.
Dr. A. W. Burwell, Niagara Falls.
Dean Charles E. Coates, Baton Rouge.
Dr. Henry E. Curtis, Lexington, Kentucky.
Professor Frank B. Dains, Lawrence, Kansas.
August Eimer, New York City.
Professor G. B. Frankforter, Minneapolis.
Professor Moses Gomberg, Ann Arbor.
Dr. G. A. Goodell, Louisville, Kentucky.
Dr. C. H. Herty, New York City.
Dr. Edward R. Hewitt, New York City.
Dr. William Hoskins, Chicago.
Dr. H. A. Huston, New York City.
Professor H. R. Jessel, Wauwatosa, Wisconsin.
Professor Louis Kahlenberg, Madison.
Dr. Milton H. Kauffman, Hollywood.
Dr. Lyman F. Kebler, Washington, D. C.
Professor J. B. Lindsey, Amherst.
Professor Henry B. McDonnell, College Park, Maryland.
Dr. K. P. McElroy, Washington, D. C.
Professor J. T. McGill, Nashville, Tennessee.
Professor J. F. McGregory, Hamilton, New York.
Dr. Charles E. Munroe, Washington, D. C.
Professor William Albert Noyes, Urbana.
Dr. C. L. Parsons, Washington, D. C.
Dr. Charles L. Reese, Wilmington.

G. W. Rolfe, Martha's Vineyard.
Dr. Ludwig Saarbach, New York City.
Dr. A. H. Sabin, New York City.
Dr. William Seaman, Glens Falls, N. Y.
Dr. F. T. Shutt, Ottawa, Canada.
Albert L. Smith, Chicago.
Dr. Harry E. Smith, New York City.
Dr. Herbert W. Smith, New York City.
Dr. Alfred Springer, Cincinnati.
Dr. George Steiger, Washington, D. C.
Professor Julius Stieglitz, Chicago.
Professor G. L. Teller, Chicago.
A. L. Winton, Wilton, Connecticut.

OBITUARY

DR. JOHN M. DODSON, professor of medicine and from 1899 to 1923 dean of the Rush Medical College, University of Chicago, former editor of *Hygiea*, has died at the age of seventy-four years.

DR. FREDERICK STARR, associate professor of anthropology at the University of Chicago from 1895 to 1923, died on August 14 in Tokyo. He was seventy-four years old.

DR. HARVEY GILMER MUDD, professor of clinical surgery at Washington University, St. Louis, died on August 16, at the age of seventy-five years.

DR. H. G. GREENISH, who recently retired from the professorship of pharmaceutics to the Pharmaceutical Society of Great Britain and in the University of London, died on August 2, at the age of seventy-eight years.

DR. OTTO STAPF, for thirteen years until his retirement in 1922 keeper of the herbarium and library of the Royal Botanic Gardens at Kew, has died at the age of seventy-six years.

SIR JOSEPH VERCO, consulting physician to the Adelaide Hospital and past president of the Royal Society of South Australia, died on July 30, at the age of eighty-two years.

THE sudden death is announced of Dr. Gustav Embden, professor of physiology in the Institute of Plant Physiology of the University of Frankfurt.

Nature records the following deaths: Professor J. W. Hinton, professor of physics in Ceylon University College, Colombo, formerly lecturer in the University of Otago, New Zealand, on July 15, aged thirty-eight years, and Sir Emery Walker, Sandars reader in bibliography in the University of Cambridge in 1924, an authority on typography, on July 22, aged eighty-two years.

SCIENTIFIC NOTES AND NEWS

THE Frederick Ives Medal for 1933 of the Optical Society of America will be presented to Dr. R. W. Wood, professor of experimental physics at the Johns Hopkins University, at a dinner to be given in his honor. The society meets at the Inn at Buck Hill Falls, Pennsylvania, from October 19 to 21.

THE honorary degree of doctor of science was conferred upon H. A. Schwartz, manager of research of the National Malleable and Steel Castings Company, by the Rose Polytechnic Institute at the fiftieth anniversary commencement exercises of the institute.

DR. SAUL ADLER, professor of parasitology at the Hebrew University in Palestine, has received the Chalmers Gold Medal of the Royal Society of Tropical Medicine and Hygiene, London. The medal has been awarded to Dr. Adler in recognition of his work as director of the Kala-Azar Commission.

WE learn from the *Journal* of the American Medical Association that a portrait of Dr. Walter H. Moursund, dean of Baylor University College of Medicine, Dallas, Texas, was recently presented to the school by the June graduating class. Dr. Raymond S. Willis, president of the graduating class, made the presentation and Drs. William W. Looney and Milford O. Rouse, the acceptance.

DR. ALFRED COEHN, honorary professor of photochemistry at the University of Göttingen, celebrated his seventieth birthday on August 2.

AT the recent meeting of the British Medical Association Dr. Frank W. Ramsay, consulting surgeon to the Royal Victoria Hospital, Bournemouth, and the Victoria Hospital, Wimborne, was chosen as president-elect of the association for 1934–35. He succeeds Dr. Thomas Gillman Moorhead, regius professor of physic at the University of Dublin.

PROFESSOR GILBERT MURRAY has been elected chairman of the International Commission on Intellectual Cooperation. Mme. Curie and Professor Rocco have been elected vice-chairmen.

DR. JEROME CLARKE HUNSAKER, vice-president of the Goodyear-Zeppelin Corporation, known for his contributions to aeronautical engineering, has accepted appointment as head of the department of mechanical engineering of the Massachusetts Institute of Technology. Dr. Hunsaker succeeds the late Professor Edward F. Miller, for many years head of the department.

GEORGE B. KARELITZ has resigned from the position of manager of the marine engineering division of the Westinghouse Electric and Manufacturing Company, South Philadelphia Works, to accept the position of professor of mechanical engineering in Columbia Uni-

versity. Mr. Karelitz intends also to engage in consulting practise in order to maintain close contacts with industry.

DR. HOWARD E. SIMPSON, professor of geographic geology, has been appointed head of the department of geology and geography in the University of North Dakota. This position carries with it also the title of director of the North Dakota State Geological Survey.

DR. FREDERIC M. HANES, of Winston-Salem, North Carolina, has been appointed professor of medicine in the School of Medicine at Duke University and head of the department of medicine in the hospital.

DR. PETER C. KRONFELD, associate professor of ophthalmology in the Division of Biological Sciences of the University of Chicago, has been appointed head of the department of ophthalmology at Peiping Union Medical College.

PROFESSOR A. F. LINDBLAD, of the department of naval architecture and marine engineering at the University of Minnesota, has resigned from the faculty and will return to the Chalmers College of Technology at Gothenburg, Sweden, where he formerly served as a member of the teaching staff.

PROFESSOR H. W. FLOREY, since 1931 Joseph Hunter professor of pathology in the University of Sheffield, has been appointed to the Sir William Dunn chair of pathology tenable at Guy's Hospital Medical School, London.

COLONEL HAROLD COLLINSON, professor of clinical surgery at the University of Leeds, has been appointed head of the department of surgery.

HAROLD WILLIAMS COLE, Ph.D. (Iowa State, '27), has been appointed to the Squibb fellowship, which has been maintained by the firm of E. R. Squibb and Sons at the Mellon Institute since 1922. Dr. Cole has specialized in the pharmacology of local anesthetics and has contributed to the chemistry and fermentation of sugar derivatives, organic antimony compounds and ephedrine intermediates.

DR. JOHN J. PHAIR, formerly bacteriologist of the Cincinnati Department of Health, has been appointed to the staff of the International Health Division of the Rockefeller Foundation. He will be at the Research Center for Undulant Fever, Montpellier, France.

Nature reports that F. E. Magarinos Torres has been appointed director of the Institute of Meteorology at Rio de Janeiro in succession to Professor Martins Costa, who has resigned.

DR. WILLIAM BEEBE, of the New York Zoological Society, has returned from a five weeks' trip on the yacht *Antares*, surveying the possibilities of ichthyological study in the Pearl Islands and Chiriqui Lagoon. Together with the staff of the department of tropical research, he sailed on August 16 for Bermuda to continue ecological work on shallow and deep-water fish.

DR. MAX EINHORN, professor of medicine of the New York Post-Graduate Medical School, and Dr. Carl F. Cori, professor of pharmacology in the School of Medicine of Washington University, St. Louis, will represent the United States at the fourteenth annual International Medical Post-graduate Course in Balneology and Balneotherapy at Carlsbad, Czechoslovakia, from September 10 to 16.

THE annual meeting of the American Academy of Ophthalmology and Otolaryngology will be held in Boston under the presidency of Dr. Burt R. Shurly, Detroit, from September 16 to 22.

THE *British Medical Journal* reports that the sixth annual scientific meeting (twenty-seventh South African Medical Congress) of the Medical Association of South Africa (British Medical Association) will be held in the University Buildings, Groote Schur, from September 25 to 30, under the presidency of Dr. E. Barnard Fuller. On the opening day the association's gold medal for meritorious services will be presented to Dr. J. A. Orenstein. A provisional program has been issued, containing notice of three plenary sessions. The first will take the form of a symposium on diet in relation to health in South Africa. The second session will be on maternal mortality in urban and rural areas in South Africa. Medico-legal problems of general practise will be considered at the third session. Other subjects will be arranged under five sections, namely, medicine, surgery, gynecology and obstetrics, public health, and special subjects, comprising ophthalmology, oto-rhino-laryngology, dermatology and venereal diseases, pediatrics, neurology and psychiatry and radiology and physiotherapy. A scientific and trades exhibition will be open during the congress; there will also be an exhibition of historical specimens and a pathological museum.

THE fourth session of the Australasian Medical Congress (British Medical Association) will be held at Hobart, Tasmania, from January 15 to 20, 1934. Dr. D. H. E. Lines has been appointed president, Drs. H. N. Butler and W. L. Crowther joint honorary secretaries and Dr. Stuart Gibson honorary treasurer. The whole of the accommodation at the University of Tasmania and the Philip Smith Teaching College has been made available to the congress through the courtesy of the chancellor of the university and the director of education of Tasmania. There will be ten sections—medicine; naval, military and air medicine and surgery; obstetrics and gynecology; ophthalmol-

ogy; oto-rhino-laryngology; public health, preventive medicine and tropical hygiene; radiology and electrical therapy; pediatrics; pathology, bacteriology, cancer research and surgery.

THE annual conference of the Museums Association opened on July 4 at Norwich, under the presidency of Sir Henry Miers, F.R.S. After an official welcome by the Lord Mayor, Alderman H. N. Holmes, Sir Henry Miers addressed the association as president for the fourth year in succession. According to the report of the meeting in the London *Times*, he gave the following account of the work of the association. During the past year the association had moved to new offices in the same building as the Library Association, Chaucer House, Malet Street. The long contemplated diploma of the association had been established, among its first recipients being Lord Elgin, Lord Crawford, the Master of the Rolls, the director of the British Museum and Sir Frederic Kenyon. Further grants by the Carnegie United Kingdom Trustees had brought the number of municipal museums aided up to thirteen, while the Empire Survey, financed by the Carnegie Corporation of New York, had been completed in Canada, South Africa and the Mediterranean area, in Australia and New Zealand and in the West Indies. The Carnegie Corporation had already allocated a sum of $50,000 for Canadian museum purposes and had appointed an advisory committee in that museum. In Great Britain six local federations of museums were doing valuable work. That only half of the smaller museums in Britain for which the Carnegie Trustees were ready to provide grants for reorganization had applied for and obtained these was largely to be explained by the financial stress, which had prevented local authorities from contributing their share of the expenditure.

A SMALL expedition from the University of Cambridge sailed from Hull on July 4 to make a zoological survey in East Greenland. The party, which has the support of the Royal Geographical Society, will travel to Iceland by the ordinary passenger route, and will join the French Polar Year Expedition under the command of Dr. J. B. Charcot, who is giving them passages out to Greenland. Dr. Charcot's vessel, the *Pourquoi Pas ?*, is making the passage to Scoresby Sound in order to relieve a party of investigators who have been making meteorological observations in Rosenvinge Bay since last August. The station has received the name of Paul Doumer to commemorate the late French President's interest in the Polar Year scheme. The *Pourquoi Pas ?* will be accompanied by the French naval icebreaker *Pollux* to ensure a rapid crossing from Iceland through the pack ice. The evacuation of the French station will probably take about four weeks. During this time, if ice conditions are suitable, the Cambridge party, which will consist of G. C. Bertram, D. L. Lack and B. B. Roberts, will attempt to sail up Hurry Inlet, a subsidiary fjord running some forty miles northwards from Scoresby Sound. Here a base camp will be established and the country around the head of the fjord studied intensively. Early in September the whole expedition will return to Reykjavik before proceeding home.

WITH 1,260,380 visitors from January 1 to July 9, inclusive, visiting the Field Museum of Natural History, it had a gain in attendance during that period of more than 58 per cent. as compared with 1932. With the peak season, which usually runs from about July 1 until October, barely begun, Mr. S. C. Simms, director of the museum, forecast a total museum attendance for 1933 that will surpass all records. On July 9 last year the total had reached 796,492 persons, or 463,888 less than have visited the museum during the same period this year. The total number of visitors for the twelve months of 1932 was 1,824,202, which was greater than in any previous year.

A VALUABLE anthropological collection has been received by the University of Missouri from Miss Frances Pearle Mitchell, a former resident of Columbia. The collection, containing interesting and historical articles from all parts of the world, will be known as the Frances Pearle Mitchell Collection. It includes 75 baskets, varying in size from tiny specimens from Mexico to the large threshing baskets of the Navajo Indians. One of especial interest is a basket made a century ago by a tribe of Aleutian Islanders now extinct. Many specimens of Indian basketry from Alaska to South America were made by Tlingit, Navajo, Apache, Pomo and other tribes. The Sudan, China, Japan and Egypt are represented. There is also a collection of shoes from China, Korea, Arabia, India, Holland and Alaska.

The Experiment Station Record reports that in cooperation with the county agricultural agents the soils and agricultural engineering divisions of the Minnesota Experiment Station are demonstrating the Mangum terrace in soil erosion control in three counties in southeastern Minnesota. One farm each has been selected in Houston, Winona and Goodhue Counties for the demonstration. The station is providing the plan for the terraces and the technical service in building them, the county agent in each instance makes the local arrangements and the owner of the farm where the demonstration is made supplies the power and labor for building the terrace. The erosion demonstrations will be used as educational projects in the county.

DISCUSSION

THE NATURAL OCCURRENCE OF CROWN GALL ON THE GIANT CACTUS, CARNEGIEA GIGANTEA

THE presence of galls on the giant cactus, *Carnegiea gigantea,* has been known to the senior author for at least twenty years. Although he has regarded the galls as unmistakable crown galls in nature, his teaching duties and work with crop plants have hitherto prevented a laboratory study supplementary to his observations in the field. Recently, however, time has been found to do this.

Galls on the giant cactus are numerous in the cactus forest near the Rincon Mountains, which was recently acquired by the University of Arizona; also in the cactus forest a few miles north of the University Cactus Forest in the foothills of the Santa Catalina Mountains. On some areas in these forests we estimate that 5 per cent. of the giant cactus plants are infected. Crown gall is the most conspicuous disease of Carnegiea in the two forests.

Both aerial and root galls occur. The aerial galls reach a diameter of two or more feet, the tissues of the galls die, and chunks of the dead tissues are sometimes scattered on the ground for a distance of several feet from the diseased plant. Small galls form lumps in the surface of the cactus, which may leave holes in the columnar trunk when the galls are "abscissed" by a layer of cork. Other galls apparently grow so rapidly that the host fails to "wall off" the enlarging cell mass. In one case a branch appeared to arise from a large aerial gall to which it is certainly attached at the present time. The branch on the gall may have been displaced from its original position on the trunk by the subsequent growth of the gall. From the ground it was impossible thoroughly to investigate the member. The gall is approximately two feet in width and about twelve feet above the ground.

The root galls may be large. On a field trip a few days ago the junior author noticed a grayish mass which was lying approximately three feet from the base of a giant cactus and partly above the soil line. When struck by the foot of the observer the mass broke from its attachment; it proved to be a root gall of the stalked type. This gall weighed eight and one half pounds, was ten inches across, and had a short stalk five and one half inches thick; it consisted of spongy parenchymatous tissue covered with grayish bark, which was one eighth to three fourths inch in thickness. Throughout the spongy tissue of the gall woody strands were distributed in much the same manner in which they occur in the normal plant.

From the galls on *Carnegiea gigantea* we have isolated a motile, polar uni- to bi-flagellate bacterium which grows on Patel's medium. Cultures on potato-dextrose agar can not be told superficially from peach and cottonwood strains of *Phytomonas tumefaciens.* Measurements of numerous individual rods agree with those of the crown-gall bacterium. Although we are awaiting results from inoculations, there is in our minds no doubt concerning the identity of the organism.

The natural occurrence of crown gall on the giant cactus and on other wild plants in Arizona raises some interesting questions. Is crown gall indigenous to the Southwest? The giant cactus forests in which our material was obtained are removed from agricultural districts and separated from farms by a belt of desert vegetation. Crown gall occurs on several wild plants in isolated places.

Of course it is not impossible that the crown-gall bacterium, *Phytomonas tumefaciens,* was brought into the country by the early Spanish missionaries. Records show that fruit trees and the vine were planted near the old missions. According to Father Kino[1] there were in Arizona, about the year 1700, gardens and vineyards containing Castilian fruit trees, including figs, quinces, peaches, apricots, pears, apples, mulberries and other trees which are susceptible to crown gall. Hedgcock[2] states that "no one can be certain as to the time of the first appearance of the disease in this country (United States). In the opinion of the writer it was introduced with plants from Europe."

Although the disease may have spread far from its possible source at the missions within two and a third centuries, the extent of the infection in our cactus forests and elsewhere in isolated areas argues against the theory of the introduction of the disease by early missionaries or by later settlers.

Finally, the writers call attention to a recent paper[3] with the (probably not intentionally) misleading title of "Crown Gall on the Sahuaro." We (and other workers) inferred from the title that crown gall had been found on the giant cactus, whereas the author had merely demonstrated the susceptibility of the plant when it is artificially inoculated. A more ac-

[1] Frank C. Lockwood, "Pioneer Days in Arizona," Macmillan Company, New York. 1932.

[2] George G. Hedgcock, "Field Studies of the Crown Gall and Hairy Root of the Apple Tree," *U. S. D. A. Bureau Plant Industry Bulletin* 186. 1910.

[3] Michael Levine, "Crown Gall on Sahuaro (*Carnegiea gigantea*)," *Bul. Tor. Bot. Club,* 60: 9–15, 1933.

curate title would have been "Sahuaro Susceptible to Crown Gall."

J. G. BROWN
M. M. EVANS

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THE SPECIFICITY OF FROG FLUKES

THERE are few animals more subject to parasitism than are frogs, and the ease with which these animals are collected and kept in captivity makes them ideal for the study of parasites of many kinds. In recent years the life-histories of a few trematodes which infect the frog have been worked out, but unfortunately very little attention has been given to the interesting problem of the specificity of these flukes for their hosts. The experimental approach to this problem is attended with some difficulty, since the mollusk, insect and frog which are involved as hosts must be laboratory-raised, and the investigator has usually been content if he has been fortunate enough to have the necessary hosts to demonstrate the life-history, without trying to find out just how specific the parasite may be for its hosts.

Considerable light can be thrown on this problem if frogs are carefully examined both within their natural range and in regions where they have been successfully introduced. A good example of the latter is to be found in the Hawaiian Islands and in the Sacramento Valley in California. In the former there are no native frogs, but such species as *Rana rugosa* from the Orient and *Rana catesbeiana* from the eastern part of the United States are well established. In a correspondence with Dr. C. H. Edmondson, of the University of Hawaii, I am informed that several hundreds of the American species have been used in his laboratories during the past few years, and not a single fluke has been found in them. Apparently the introduced bullfrog lost its flukes because of the lack of suitable mollusks or insects which serve as hosts. However, trematodes from domestic mammals which were reared on the islands have been found.

The frog "plant" in the vicinity of Gridley, California, was made several years ago, and at present the bullfrog has spread over most of the rice fields in that part of the state. They are very common and are even penetrating the near-by mountain streams, where they are living side by side with two California species, *Rana aurora* and *Rana boylii*. Although the two latter frogs have been found to harbor eight species of trematodes, none has ever been found in the introduced *Rana catesbeiana*. We use this frog in the elementary classes in biology and physiology, and I have personally examined the intestine, bladder and lungs of a large number but without the trace of a trematode. This is of especial interest, because two species of snails of the genus *Gyraulus* and at least seven species of dragonflies belonging to the genus *Sympetrum* are found in California, and species of these genera serve as hosts for certain frog lung flukes in Michigan and for other frog lung flukes in California. Both of the above-mentioned genera are represented in this locality.

Young bullfrogs and a single eastern leopard frog, *Rana pipiens*, were fed the metacercaria of *Ostiolum oxyorchis*, a common lung fluke in *Rana aurora*, but without results.

These observations indicate that there is a rigid specificity for the hosts by frog flukes and that the introduction of frogs into new regions may result in the loss of flukes because of the lack of suitable hosts. If this specificity should prove experimentally to be as rigid as is indicated, it might be used as a means of determining the identity or assisting in the differentiation of species of mollusks concerning which there is at present a difference of opinion. Whether this freedom from these parasites plays any appreciable part in the success of the adventitious bullfrogs over the indigenous frogs can not be stated, because it is doubtful whether the frog flukes actually harm their hosts seriously, but in the Gridley rice fields the bullfrogs outnumber all other native species ten to one. However, many other factors might cause this difference in numbers.

LLOYD G. INGLES

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POST-BOLSON FAULTING IN NEW MEXICO

DURING a recent trip into the San Andreas Mountains, the writers noted two low but interesting scarps in an area of bolson deposits. These were located at 25.2 miles and at 29.1 miles, respectively, west of Tularosa, on New Mexico state highway number 52. Unfortunately, time did not permit tracing these features either way from the highway, but a few facts of some importance were observed.

Both escarpments are moderately straight, and about the same height, approximately fifteen feet. Both face east, and neither one, at least within sight of the highway, shows any indication of an opposite-facing cliff, as would be the case if they were the banks of arroyos.

Even more interesting is the fact that each scarp shows a gentle but unmistakable back slope to the west, that of the easternmost being about fourteen feet per mile and extending for 3.9 miles; that of the westernmost thirty feet per mile for 1.0 mile. Both are considerably west of the center of the Tularosa basin. As a result of the back slopes, the surface of the basin floor actually declines westward from the scarps towards the adjacent mountains, just the reverse of what would be expected, were the intervening

surface occupying the original position produced by aggradation from the ranges to the west.

Still more significant is the fact that the crest of the westernmost of these scarps, that is, the one closest to the mountain range, is at a lower elevation than the one farther east toward the center of the basin, by about fifty feet.

Many observers have described scarps in bolson deposits as wave-cut lake cliffs. And there are, of course, in the arid southwest, many unmistakable old shorelines of former playa lakes now extinct. The fact, however, that these scarps, both of which are on the west side of the basin and face eastward, show long and fairly even backslopes to the west in the direction from which the sediments making the floor in this part of the basin probably came, surely indicates that they are not wave-cut cliffs of now extinct lakes, and points very conclusively to post-bolson faulting, which has produced the cliffs and tilted the floor of the basin.

The fact, also, that, though both scarps face east, the crest of the western one is at a lower elevation than that of the eastern is quite as indicative of fault origin.

It is therefore believed that there has been faulting in the area, not only recent enough to displace the bolson floor, but so fresh as to have permitted but little dissection of the scarps since the faulting. The region is so arid, however, that it is difficult to estimate how long ago that might have been.

C. L. DAKE

MISSOURI SCHOOL OF MINES

L. A. NELSON

TEXAS SCHOOL OF MINES

FENSTREAMS

IN Virginia there is a broad overthrust fault by virtue of which the Cambro-Ordovician limestone has been shoved northwestward more than ten miles across younger formations. In Montgomery and Pulaski counties there are four areas several miles back from the northwestern edge of the overthrust limestone from which the limestone has been removed by erosion, producing fensters—windows in the limestone through which the underlying younger rocks are exposed. Streams, meandering on the peneplained limestone, were let down on to the shales and sandstones of the younger formations, retaining the drainage pattern of the limestone streams. Subsequently, these superimposed streams adjusted their courses to the softer strata, but are still crossing enough hard beds to prove their superimposed character. There has been thus produced a type analogous to superimposed streams, but differing from them in that the superposing strata are older instead of younger than those on which the drainage is superimposed. For this type of stream the name fenstream (fenster stream) is proposed.

R. J. HOLDEN

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SELECTIVE ABSORPTION OF IONS NOT CONFINED TO YOUNG ROOTLETS

IT has been generally understood that the selective absorption of ions by plants is entirely a function of the absorbing tissue of the youngest and most active rootlets and is confined to a more or less restricted zone lying close behind the subapical growing region and usually characterized by the presence of root hairs.

In studies conducted, during 1932, at the Boyce Thompson Southwestern Arboretum, results were obtained which conflict with this traditional view. By cutting off the young, unsuberized portion of Citrus and Vitis roots and carefully sealing the cut ends, selective absorption of phosphate and nitrate was found to take place in the woody parts of the roots. This was demonstrated for small seedling trees and for single roots of large trees growing both in the field and in concrete lysimeters. Briefly, the experimental procedure was to excise the younger part of the root; carefully seal the wound; place this sealed root in a nutrient solution of known concentration, containing both nitrate and phosphate; and to determine by chemical analysis the rate at which these nutrients were removed from the nutrient solution. By using colorimetric methods now available, it was possible to determine minute changes in the nutrient solution, and thus establish the fact that ion absorption was selective.

So far as is known, this experimental procedure has not been employed previously in differentiating between ion absorption in the area of root elongation and the older parts of the root.

These experiments have now been extended to include a number of additional plants and not a single exception to the above observation has been found.

One important phase of this work has dealt with temperature effects. Selective absorption was found to occur not only within the temperature range of root elongation but also at non-killing temperatures above and below this range.

The above observations have been confirmed by numerous repetitions and modifications in experimental technique, with particular attention to the possibility of bacteria or fungi reducing the ion concentration of the nutrient solution, and we are firmly convinced from these data that selective absorption is not a function of young, elongating rootlets only.

F. J. CRIDER

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SCIENTIFIC BOOKS

RECENT ZOOLOGICAL TEXT-BOOKS. II

DURING the first part of the year 1933 several new zoological text-books were published in the United States. These were apparently written to be sold to average teachers. On the whole, they are not as progressive and up to date as those now being produced in Europe. Most American writers appear to be concerned more with presenting a complete catalogue of facts than with giving their readers an interesting and inspiring picture of the present status of biology. No one in America to-day is producing such thoughtful and critical works as Agassiz, Cope, Parker and Haswell, Brooks, Lankester, Shipley, Harmer, Gadow, Calman, Imms and others have written. The present-day writers of text-books on the fundamentals of biology in Europe make little or no mention of the work of Americans, except in special fields such as genetics. Perhaps this is because the writers in the new world are not making an earnest effort to give thoughtful consideration to current biological progress.

Glossaries continue to present many careless, inadequate or improperly restricted statements and half truths which give students wrong ideas. For example, the word "artifact" is properly defined in one text as "a natural object modified by man, such as a stone implement," but another text limits the same word as "a formation seen in the cellular structure of stained sections due to the fixation process." In the same two works "ambulacral" is defined as "pertaining to the rows of openings through which the tube feet of echinoderms are extended; hence, ambulacral system of which the tube feet are a part," and as a "term applied to radial areas on echinoderms along which run the nerves and water tubes, and a series of tube feet."

In the last review[1] published the present writer made some careless and ambiguous statements which have been properly criticized.[2] An author's name is not a part of the scientific name of a species, but it "should be appended to the scientific name of an animal at least once in a publication using the name." The reviewer has received letters as a result of the published criticism cited[2] which express the view that the author's name *should* be a part of the name of a species, but it is not at present *required* by the "International Rules of Zoological Nomenclature,"[3] which should of course be strictly followed if zoological terminology is to progress. In regard to the capitalization of the names of genera, orders and classes, it is of course proper to capitalize them when they are used as scientific names, but when they are continually used as common names there is a growing tendency to begin them with small letters; *i.e.*, if *bacteria* is proper, why not *protozoa;* if *hydra,* why not *amoeba?* A change in the original spelling of a generic name is of course not permissible under any circumstances.

Perhaps this problem of terminology for the larger groups of animals will not ever be settled properly by having each author choose such terms as fulfil his ideals or suit his fancy, but should be subject to general action and agreement by zoologists.

Text-book of General Zoology. By W. C. CURTIS and MARY J. GUTHRIE. Wiley, New York, $3.75. 2 ed., xv + 588. 1933.

"The reduction of certain parts has made possible the addition of chapters upon phyla not included in the first edition and thus a more comprehensive survey of the Animal Kingdom, without undue restriction of the chapters dealing with general terminology." The writers believe that "college and university instruction must have a certain regard for the existing organization of subject-matter, for example, for Zoology as conceived by zoologists," and therefore have attempted "to give the student what he must know in order to understand something of the subject," rather than to give him "what he thinks he wants to know and can obtain in a way that takes little effort." The book begins with a consideration of definitions, history, systems of classification and scientific methods. The introduction is followed by chapters on the natural history of vertebrates, organ systems related to metabolism and irritability, structure and activities of cells, reproduction and development, heredity and variation, classification and organization of animal groups, Protozoa, Porifera, Coelenterata, Platyhelminthes, Nemathelminthes, Molluscoidea, Trochelminthes, Annulata, Mollusca, Echinodermata, Arthropoda and the history of organisms. The " 'project' in the first part of the work is to teach the student something of the principles of Zoology as illustrated in his own type of animal body; the 'project' in subsequent chapters is to teach him how other animal bodies may be compared with his own and to impart some of the many interesting facts about animals." The text is intended for use in a course in which the frog plays an important rôle in the laboratory.

Elements of Biology with Special Reference to Their Rôle in the Lives of Living Animals. By JAMES WILLIAM BUCHANAN. Harper, New York. $3.00. xxii + 478. 1933.

The object of this text is "to impart such principles and concepts as will enable the student to appreciate

[1] SCIENCE, 77: 169–172, 1933.
[2] SCIENCE, 77: 389, 1933.
[3] *Proc. Biol. Soc. Washington,* 39: 75–104, 1926.

the unity in Nature and the place of living organisms, including Man, in that unity; to instill an understanding of the major laws that govern living organisms and a recognition of the operation of these laws in determining broad social and economic controls in human society; to impart useful information and information of such a character that a habit of observing caution in the face of all forms of scientific and intellectual quackery will be developed. A fourth objective that is self-evident and one which General Biology holds in common with other academic disciplines is the development of student power of clear and logical reasoning based upon accurate observation of established facts. . . . An attempt is made here to develop just so much of the principles of Chemistry that at the very start the student is indoctrinated with the concept of Mechanism and establishes as a point of departure the First Principle, that life is dynamic." The twelve chapters discuss the nature of life and living materials; cells; unicellular and multicellular plants and animals; order among animal types; structure and function of multicellular animals; reproduction and development; growth, age, and death; heredity; the organism and its environment; the history of life and its interpretation; and the general aspects of the science of biology. The figures in this book are generally quite good; the writing impresses the reviewer as being verbose and careless.

A Text-book of General Biology. By E. GRACE WHITE. Mosby, St. Louis. $3.00. ii + 615. 1933.

This text-book for a course in general biology has been "written with the conviction that a text-book should do more than repeat the work of the classroom. It should contain material to clarify and amplify discussion; it should provide sufficient descriptive detail for reference and comparison; and it should give the beginning student glimpses of many possible fields for future specialization. . . . Throughout the book structure has been handled apart from function. In the course as presented by the writer the physiological material is discussed in the classroom, and the morphological material is handled in the laboratory, the book serving as a laboratory guide." The book is divided into three sections: (1) "The Unity of Life," in which a grasshopper, a green plant, life and cells are discussed; (2) "Progressive Organization in Animals and Plants"; and (3) "Problems of Biology"—metabolism, protoplasm, cells, sex, adaptations, heredity and evolution. Many strange statements are made in this book: abdominal [*sic*] segments are said to be present in Apus but absent in Branchipus (p. 333); the excretory organs of Malacostraca are affirmed to be green glands on the antennae (333); the coelom of Nemathelminthes is said to be an outgrowth from the archenteron (336); "antirhachitic, opposed to the formation of rickets in bones" (542); "anaerobe, a bacterial type using oxygen released by its own activity from inorganic compounds, and so capable of existing in the absence of air" (541); etc. Apparently the author has a limited view of many aspects of biology or is careless in thought and expression.

Invertebrate Zoology. By ROBERT WILHELM HEGNER. Macmillan, New York. $3.75. xiii + 570. 1933.

This is an expansion and modification of an "Introduction to Zoology" by the same author, who is a well-known writer of zoological text-books. It contains detailed accounts of various types of invertebrates in systematic order. The physiology and behavior, as well as the morphology, of invertebrates are discussed. Some new, and perhaps questionable, usages in terminology are introduced: *e.g.*, the use of "organs" and "systems" for parts of protozoa; the occurrence of "reflex types of reactions" in protozoa. The book gives a relatively complete and modern account of invertebrates.

An Introduction to the Vertebrates. By LEVERETT ALLEN ADAMS. Wiley, New York. $3.50. v + 414. 1933.

The book presents "first, an outline of the characteristics on which the modern system of classification of chordates is based; second, a general view of each of the five classes—fishes, amphibians, reptiles, birds, and mammals—with particular reference to representatives used in the laboratory; and third, a comparative analysis of anatomical systems and specialized structures." It appears to be original, interesting and scientific.

A Guide to Human Parasitology for Medical Practitioners. By D. B. BLACKLOCK and T. SOUTHWELL. Williams & Wilkins, Baltimore. $4.00. vii + 271. 1932.

This book attempts to present briefly the essentials of parasitology which will be useful to medical practitioners. It considers the parasites in various groups of animals in systematic order. It contains chapters on the examination of materials, treatment and apparatus generally used in the study of parasites. There is also a series of diagrams illustrating life histories. One chapter is devoted to tables which show geographic distribution; parasites which man may acquire from water and other foods, arthropods, snails, feces and soil; stages of parasites infective

for man and where found; and a summary of diagnostic features of parasites. In some cases a limited or partisan point of view is presented; *e.g.* (p. 169), the statement is made that *Ascaris lumbricoides* L. occurs in pigs and man, which ignores the work of Mrs. Caldwell, Schwartz and other parasitologists in the United States.

Plant and Animal Ecology. By J. W. STORK and L. P. W. RENOUF. Murray, London. 5 s. x + 197.

A little book which should be useful to those who have had limited training in biology but who are interested in outdoor life.

A. S. PEARSE

DUKE UNIVERSITY

SOCIETIES AND MEETINGS

THE NEW HAMPSHIRE ACADEMY OF SCIENCE

THE fourteenth annual meeting of the New Hampshire Academy of Science was held from June 2 to 4, 1933, at Glen House, at the eastern base of Mount Washington.

Interest in the meeting centered about the Mount Washington Observatory, which has been maintained since last October on the summit at an elevation of 6,284 feet. The observatory cooperated with the International Polar year and with the Blue Hill Observatory of Harvard University. It was aided by a grant from the academy.

Mr. Joseph B. Dodge, director, spoke on "The Organization of the Observatory." Mr. R. S. Monahan, one of the observers, gave an illustrated talk on "Some Experiences on the Summit," and Professor Charles F. Brooks, of Harvard University, discussed "The Scientific Value of the Mount Washington Observatory." Several members made the trip to the summit and inspected the equipment of the observatory.

Other papers of major interest were "Cosmic Rays," with demonstrations by Professor G. F. Hull, "Bacterial Variations," by Professor K. N. Atkins, and the presidential address on "The Chemistry of the Atom," by Professor N. E. Gilbert, all of Dartmouth College.

The following officers were elected for 1933–34: *President,* Mr. Samuel P. Hunt, Manchester; *Vice-President,* Mr. Henry S. Shaw, Exeter; *Secretary-Treasurer,* Professor George W. White, department of geology, University of New Hampshire; *Member of the Executive Council,* Professor Norman E. Gilbert, department of physics, Dartmouth College.

THOMAS G. PHILLIPS,
Retiring Secretary

SUMMER MEETING OF THE MINNESOTA ACADEMY OF SCIENCE

WITH an attendance of 125, the reorganized Minnesota Academy of Science held its first annual summer meeting on the farm of Dr. R. B. Harvey, in the St. Croix River Valley near Stillwater, Minnesota.

Following a short business meeting for the election of new members the following papers were presented.

"Anthropology of the St. Croix," R. D. Brown, University of Minnesota.

"Things of Interest in the Geology of Central Minnesota," Professor Geo. A. Thiel, University of Minnesota.

"Animal Life in the St. Croix," Professor Samuel Eddy, University of Minnesota.

"Flora of the St. Croix," Professor A. H. Larson, University of Minnesota.

The afternoon was devoted to field trips of interest to all. Two Indian caves containing remnants of pottery were visited first. Plants and animals encountered were discussed. From the caves, the party visited two Indian burial mounds which had been excavated by members of the academy. Two skeletons, estimated to be from 400 to 500 years old, and a number of fragments of pottery were found. The third excursion was to view a number of well-preserved Indian pictographs on the sandstone bluffs of the St. Croix River.

Much enthusiasm was evidenced by the members and it is planned to make the summer meeting an annual affair, meeting in different sections of the state, where objects of scientific interest are available.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A MICRO VESSEL FOR GLASS ELECTRODE DETERMINATIONS OF HYDROGEN-ION ACTIVITY OF BIOLOGICAL FLUIDS

INVESTIGATIONS of the hydrogen-ion activity of body fluids of insects during metamorphosis by means of the glass electrode have led to the development of a micro vessel which may be filled by approximately 0.03 cc of fluid and which prevents errors due to the loss or addition of gases such as CO_2. The vessel is of simple construction and it permits the manipulations to be made easily and quickly. It is used in combination with a glass membrane mounted on a tube according to the method of MacInnes and Dole[1]

[1] D. A. MacInnes and M. Dole. *Jour. Am. Chem. Soc.,* 52: 29, 1930.

and a silver-silver chloride electrode prepared as described by Stadie, O'Brien and Laug.[2]

The micro vessel into which the glass electrode fits is essentially a modified 3-way Pyrex glass stop-cock. A view of the vessel and electrode is shown in Fig. 1.

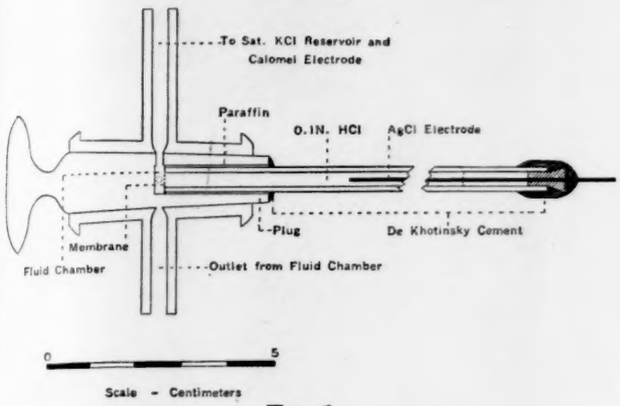

FIG. 1

The center arm of the collar of the stop-cock is modified to form a small funnel through which the sample is introduced into the fluid chamber in the center of the plug. This is pictured in Fig. 2 which shows a view in cross-section through the center of the fluid chamber looking towards the glass membrane. The arm of the collar which in the accompanying diagrams is indicated as being the longer connects with the reservoir for saturated KCl and with the calomel electrode. The opposite arm of the collar serves as an outlet from the fluid chamber and is used in filling as an exit for excess fluid and in flushing out the chamber to wash it and the membrane.

The plug of the stop-cock is modified by drilling a circular hole, 7 mm in diameter, from the end of the plug opposite the handle to the center of the plug (Fig. 1) and just through two holes, 1.5 mm in diameter (Fig. 1 and Fig. 2, a and b) drilled at a right angle to each other to communicate with the bores of the arms of the collar. This 7 mm hole serves to accommodate the glass tube bearing the membrane.

The glass tube with the membrane is mounted in the stop-cock plug so as to leave a small fluid chamber at the end of the glass membrane. The capacity of the fluid chamber depends upon the level at which the glass membrane is placed when the tube is mounted in the plug. By means of paraffin, the tube is sealed into the plug or it may be mounted by means of a piece of thin rubber tubing placed between the tube and its support according to the method of Stadie, O'Brien and Laug.[2] The former type of mounting can be conveniently carried out in the following manner. Each of the two small holes at the sides of the plug is closed by sticking a small piece of adhesive tape over the hole and a small quantity of clean mercury, equal in volume to the desired capacity of the fluid chamber, is placed at the bottom of the 7 mm hole in the plug. The tube with the glass membrane is introduced into the hole so that the membrane touches the surface of the mercury and flattens it out somewhat. Clamps are employed to hold the tube and plug in the proper position, and melted paraffin is allowed to run into and fill the entire space between the tube and plug so as to touch the mercury. After cooling, a small ring of de Khotinsky cement is placed around the end of the plug to further seal the tube to the plug (Fig. 1). The adhesive tape and mercury are then removed from the plug.

A film of paraffin is placed around the inner surface of the tube bearing the membrane to form a ring about 2 cm wide with the center of the ring about 2 cm from the open end of the tube. The glass electrode is partly filled with 0.1 N HCl so that when the silver-silver chloride electrode is inserted into the acid and sealed in place the meniscus of the acid solution will be in about the center of the paraffin ring. This leaves a small air space at the end of the column of the acid to compensate for expansion and contraction due to temperature changes which may occur when the electrode is not in use and which might otherwise cause breakage of the membrane. The paraffin ring on the inside of the tube permits the formation of a proper meniscus. A piece of fairly thick silver wire (No. 20) projecting about 7 cm into the tube is used in forming the silver-silver chloride electrode. The wire is held rigid by a small cork covered with a fairly thick coating of de Khotinsky cement. These precautions eliminate the danger of vibration and rotation of the wire in the acid during manipulation. In agreement with MacInnes and Belcher[3] we have found that the silver-silver chloride electrode does not give constant potentials if it moves in the acid solution so as to disturb the surface of contact. The entire outside surface of the glass electrode tube is finally given a thin uniform coating of clean paraffin. The plug is lightly greased, except for a narrow ring in the middle part, and placed within the collar.

In mounting the vessel and glass electrode in the constant temperature chamber a piece of rubber tubing is placed over the arm of the glass electrode vessel, which connects with the KCl reservoir and calomel electrode. A supporting clamp fits over this rubber tubing and the vessel is mounted with the funnel on top and the handle of the plug placed so that it may be rotated by the left hand.

[2] W. C. Stadie, H. O'Brien and E. P. Laug. *Jour. Biol. Chem.*, 91: 243, 1931.

[3] D. A. MacInnes and D. Belcher. *Jour. Am. Chem. Soc.*, 53: 3315, 1931.

To make the KCl junction the plug is rotated until the holes (a) and (b) are in line with the inlet funnel and the arm connecting with the KCl reservoir respectively as shown in Fig. 2. When the saturated KCl

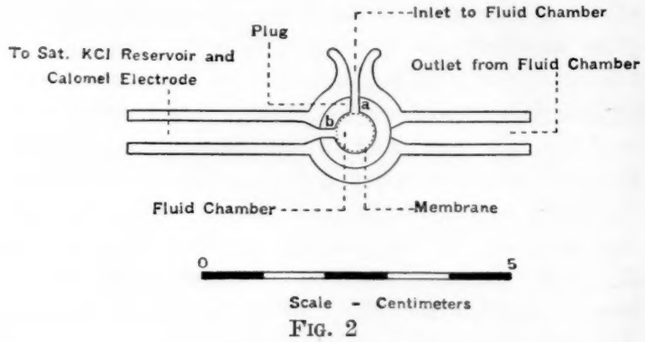

FIG. 2

solution begins to run into the fluid chamber the plug is rotated until the hole (a) communicates with the outlet from the fluid chamber and hole (b) with the inlet funnel. By means of rubber tubing, the fluid is sucked from the chamber through the arm serving as an outlet and into a waste bottle placed in the suction line. Continuing the suction, the fluid chamber is rinsed out by introducing distilled water from a rubber-tipped medicine dropper into the inlet funnel. If necessary, soap solution or alcohol may be used, followed by distilled water, and suction is discontinued when the fluid chamber is practically dry. The fluid whose pH is to be determined is then introduced into the fluid chamber and when it begins to run into the outlet arm, after the chamber is full, the plug is rotated in the same direction as before (clockwise in Fig. 2) until the hole (a) just fails to communicate with the KCl bridge. This closes hole (b) and the E.M.F. is measured. After the freshly greased plug has been wet with KCl solution in the middle by previous rotation of the plug, it is sufficient to bring the margin of the hole (a) in line with the margin of the bore of the KCl bridge without having the two communicate fully with each other in making a measurement. With buffer solutions this procedure is desirable and gives steady and reproducible potentials.

The glass and calomel electrodes are mounted in an electrically shielded, thermostatically controlled air chamber provided with an air circulator. In the measurements of the potentials, we have found the thermionic vacuum tube potentiometer described by Hill[4] to be highly satisfactory.

With this glass electrode assembly accuracy usually reported by other workers may be attained. Over 600 determinations of hydrogen-ion activity made on 16 different standard phosphate buffer solutions, ranging in pH from 5.24 to 7.22, have shown that an accuracy within 0.01 pH unit is readily obtainable. It is not unusual, in making 15 to 20 consecutive measurements on a given buffer solution, taking a different sample each time, to obtain voltage readings whose variations correspond to a difference not greater than 0.003 pH unit. Measurements on body fluids of larvae and pupae of more than 500 individual insects in different stages of metamorphosis[5] indicate that this micro vessel with the glass electrode is highly suitable and convenient for use with biological fluids.

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SPECIAL ARTICLES

THE RÔLE OF PEROXIDASE IN THE DETERIORATION OF FROZEN FRUITS AND VEGETABLES

OXIDATION, especially following injury to the tissues by freezing, apparently is responsible, at least in part, for the discoloration, browning, loss in flavor and production of certain objectionable unnatural flavors which occur during the freezing, storage and thawing of fruits and vegetables. These changes, which occur in the presence of air, apparently are catalyzed by the oxidases present in "oxidase plants," such as apricots, peaches, etc. Loss of organic peroxide or removal of oxygen from the tissues by biological or other means, or inactivation of the oxygenase present markedly improves the keeping quality of the oxidase plants. However, we find that "peroxidase plants," such as pineapple, orange, peas, string-beans, spinach, asparagus, etc., are also subject to marked deterioration during freezing storage. We have found that slices of pineapple exposed to air darken in color and deteriorate in flavor upon prolonged storage at 0° F. The deterioration in flavor of frozen orange juice and to some extent of pineapple juice is largely due to oxidation. It is difficult to believe that this deterioration is due to the peroxidases present, and that an incomplete oxidizing system will catalyze the type of changes observed. The evidence for orange juice leads us to believe that the oxidation is non-enzymatic in nature. However, oxidizing systems other than the conventional one composed of oxygenase, peroxidase and catechol may be involved.

Unnatural hay-like flavors develop in vegetables during freezing and subsequent thawing. These

[4] S. E. Hill. SCIENCE, 73: 529, 1931.

[5] The results of this work will be reported at an early date.

flavors form during storage at −17.5° C. (0° F.) in vegetables exposed to air. Definite changes in flavor occur in two months, and the off-flavors increase in intensity during storage. Joslyn and Cruess[1] and Joslyn[2] have reported that heating for 1 or 2 minutes in steam or boiling water at 100° C., followed by cooling, was sufficient to prevent the appearance of these hay-like flavors during storage at −17.5° C. for over 8 months. Subsequent tests by us and others have confirmed these findings. Blanching of the vegetables also resulted in a greener color, stable to heat during cooking.

In the course of investigations on the nature of these changes, very striking results were obtained on blanching peas, string-beans and spinach at various temperatures for 2 minutes in water. We found that there was a critical temperature range, somewhat different for each vegetable, at which the color, flavor and texture was most benefited by heating. These temperature ranges were 71 to 76.5° C. (160° to 170° F.) for peas, 82.2 to 90.6° C. (180° to 195° F.) for string-beans and 73.9 to 82.2° C. (165° to 180° F.) for spinach. Blanching below the temperatures given did not entirely inhibit formation of off flavor, and blanching at higher temperatures resulted in loss of fresh flavor and, especially for peas and spinach, the formation of other objectionable flavors, *e.g.*, "cooked" flavors. The texture of the cooked vegetables was also best in approximately the same temperature range, becoming very soft when blanched at the higher temperatures. Vegetables blanched below these tempratures, in general, did not retain the bright green color during cooking, becoming a dull green.

It was found that peas were most susceptible to the formation of hay-like flavors and string-beans least. The hay-like flavor in string-beans after four months' storage was least objectionable and that in spinach most. Unblanched spinach had a fish-like "keroseney" flavor rather than hay-like flavor.

In view of the fact that this change in the favor of vegetables was more intense in the presence of air and was reported to be absent in vegetables stored in cans closed under vacuum, it was thought that vegetable oxidases were in part responsible for these changes. These vegetables were found to turn benzidine blue in the presence but not in the absence of H_2O. Thus a complete oxidase system was not present. The temperatures at which the peroxidases present were inactivated after heating for five minutes so far as the benzidine test is concerned were found to be at about 90° C. However, the rate of color formation in presence of benzidine and H_2O was markedly reduced at temperatures of 70° C. and above and the color formed at higher temperatures was not a true blue color, being a brownish blue.

A very marked difference between the unblanched samples and those blanched at temperatures below the ranges given was found. Although blanching at 70° C. (140° F.) did not inhibit the formation of some hay-like flavor in peas, the intensity of off flavor was markedly less than in the unblanched sample. Similar results were found for other vegetables.

The fact that the vegetable peroxidases were inactivated at temperatures above the desirable range and that peroxidase was present in the tissues of vegetables which retained their flavor during freezing storage lead us to believe that it may not be the chief causative agent involved in the deterioration. Neither tyrosinase nor active proteases were found in these vegetables. It is possible that other oxidizing systems may be involved in these changes. These investigations are being continued and more complete results will be published in the not too far distant future.

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[1] M. A. Joslyn and W. V. Cruess, *Fruit Products Journal*, 8 (7): 9–12, 8 (8): 9–12. 1929.

[2] M. A. Joslyn, California Agr. Expt. Sta. Cir. 320. 1930.

DEVELOPMENT OF CERCARIA MACROSTOMA FAUST INTO PROTEROMETRA (NOV. GEN.) MACROSTOMA[1, 2]

THE life history of *Cercaria macrostoma,* a cystocercous (mirabilis) cercaria, has been experimentally determined. The adult is *Proterometra macrostoma* nov. gen., a member of the family Azygiidae Odhner.[2, 3]

The author has found *Cercaria macrostoma* in *Goniobasis livescens* from the Salt Fork branch of the Vermilion River at Homer Park, Illinois, and in *Pleurocerca acuta* from the Oconomowoc River, Wisconsin. Pratt[4] reported immature specimens under the name *Cercaria fusca* in *Goniobasis livescens* from Oneida River, New York, and Smith[5] described the mature form under the name *Cercaria melanophora* from *Goniobasis* sp. in Alabama. Cahn[6] reported

[1] Contributions from the Zoological Laboratory of the University of Illinois, under the direction of Henry B. Ward, No. 441.

[2] E. C. Faust, "Two New Cystocercous Cercariae from North America," *Jour. Parasit.*, 4: 148–153, 1918.

[3] T. Odhner, "Zum natürlichen System der Digenen Trematoden," II *Zool. Anz.*, 37: 237–253, 1911.

[4] H. S. Pratt, "A New Cystocercous Cercaria," *Jour. Parasit.*, 5: 128–131, 1919.

[5] S. Smith, "Two New Cystocercous Cercariae from Alabama," *Jour. Parasit.*, 19: 173–174, 1932.

[6] A. R. Cahn, "Life History of a New Fork-Tailed Cercaria," *Jour. Parasit.*, 13: 222, 1927.

experimental infection of Centrarchidae with a giant yellow cercaria, but identified neither larva nor adult. The author has examined living or preserved specimens of all the preceding and they are all identical with *Cercaria macrostoma*.

The rediae found in the liver and mantle cavity of the snails are yellow sausage-shaped sacks varying from 1 to 8 mm in length. No intestine is present, but at the more pointed end is a stunted pharynx surrounded by a few muscle fibers. The cercariae develop directly from germ balls in the redial cavity by elongation and differentiation. Upon emergence the distome which previously lay in front of the tail is drawn back into a roomy expansion in the anterior part of the tail, where it remains during the free-swimming period.

Cercaria macrostoma is about 6 mm long and bright yellow; the anterior part of the tail is covered with large rounded papillae. The unforked part of the tail is about 5 by 1 mm, the furcae about 1 by 1 mm and the distome about 1.3 by 0.8 mm. The distome is well developed and possesses all adult structures, including the genital organs which are functional; the cirrus pouch and the uterus contain active spermatozoa and the uterus from none to 50 eggs. The distomes break out of their tails when immersed in 0.1 per cent. solution of hydrochloric acid.

Cercaria macrostoma emerges from the snail between 7 and 11 P. M., swimming with a retrograde sculling motion typical of cystocercous cercariae. The color, size and motion of the cercaria make it the kind of an object which attracts fish. Cercariae were fed to members of different families of fish, but they infected only the Centrarchidae. In about 30 days, nearly 100 per cent. of the adult distomes which contained the maximum number of eggs (100 to 150) could be recovered from the gills, esophagus and stomach of infected fish.

Proterometra macrostoma is a small very contractile worm with a large powerful oral sucker opening ventrally and an acetabulum about one half as large, posterior to the middle of the body. Following are the average length and width of structures in living specimens: distome expanded 3.11 by 0.87, contracted 2.28 by 1.38; oral sucker 0.59 by 0.62; acetabulum 0.29 by 0.3; pharynx 0.11 by 0.12; ovary 0.22 by 0.23; testes 0.41 by 0.22 mm. Measurements vary a great deal, due to muscular contraction and expansion which the worm may undergo.

The extremely heavy cuticula is frequently raised in folds, due to contraction of the three strong muscle layers. Numerous very heavy parenchyma muscles lie among and median to the vitellaria. The digestive system is typical of the family Azygiidae. The excretory system consists of a bladder reaching only to the testes, and a pair of lateral tubes extending to the oral sucker, then branching into several tubules, one pair of which meets anterior to this sucker. The round ovary lies behind the acetabulum in the median dorsal line and the two oval testes lateral and ventral to the ovary. The double row of follicular vitellaria extends from the oral sucker to the posterior end of the body. The vitelline ducts empty through a vitelline reservoir into a typical Azygiid shell gland complex. The uterus runs along the dorsal surface from the ovary to the oral sucker in loose irregular loops, then back to the genital pore which lies immediately in front of the acetabulum. The eggs increase from 65 to 95 μ in length and 34 to 75 μ in width during passage through the uterus. The cirrus pouch is a typical Azygiid structure in which the coiled seminal vesicle opens through a sphincter (Verschlussapparat Looss) into a globular cavity at one end of the prostate gland. The ductus ejaculatorius and metraterm open by a common pore into the genital sinus, in which as many as 25 eggs may be held. When the eggs leave the body, the shell is covered by long transparent filaments and contains a well-developed miracidium with 4 anterior bristle plates.

Proterometra macrostoma has been found in the following fish: *Pomoxis annularis, Pomoxis sparoides, Ambloplites rupestris, Chaenobryttus gulosus, Lepomis cyanellus, Lepomis humilis, Lepomis pallidus, Micropterus salmoides* and *Micropterus dolomieu*.

Protometra nov. gen. is separated from the 4 genera of the Azygiidae, Otodistomum Stafford, Azygia Looss, Leuceruthrus Marshall and Gilbert and Ptychogonimus Lühe by the location of the uterine folds and vitellaria which in it extend anteriad beyond the cirrus pouch. *Proterometra macrostoma* is a small compressed Azygiid in which the posterior end has not elongated. Consequently, all the organs are crowded together and the uterus and vitellaria are pushed forward from their more typical location.

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